AIR-CONDITIONING*

ITS RELATION TO UPPER RESPIRATORY INFECTIONS

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THE subject of air-conditioning has become a popular one in recent years, but, strangely enough, its popularity has been developed by ventilating engineers and not by physicians. From a technical standpoint I think it should still belong to the engineers, because the complex formulae they must use in solving difficult problems would baffle most of us. I do believe, however, that we should become more familiar with what is being done so that we may assist in the proper installations for various conditions.

EARLY OBSERVATIONS ON AIR-CONDITIONING

The first experimental work on air-conditioning was done in 1750 by Pilcet, who showed that the breathing of air by animals reduced the oxygen content and increased the carbon dioxid content. He theorized that eventually air in rooms would be devitalized to such an extent that it would not support life, and this was a perfectly sound theory, if the vitiating of air was carried on to a point where the predicted results could be obtained. But the practical application was not carried out to the point where it would show that, in the usual conditions encountered, this condition was rarely found. From the carbon dioxid and similar theories, the scientists arrived at the amount of fresh air that was needed to keep the carbon dioxid content below the supposed danger line.

These practices continued until the time of Le Blanc in 1842, and others, who disclaimed the old theory and maintained that it was not the carbon dioxid that caused the feeling of discomfort and drowsiness. Von Pettenkoeffer advanced the theory that the air was fouled in crowded spaces by organic substances, either exhaled or exuded from the bodies of the persons present. This theory was never proved, and as a result the original theory of carbon dioxid poison and the controlling of air to prevent it alone was the general practice in ventilation.

RECENT ADVANCES IN AIR-CONDITIONING

At the annual meeting of the American Society of Heating and Ventilating Engineers, in 1911, Guelich and Evans denounced ventilation as it was then practiced. They blamed the physiologists and the doctors who, they said, could not agree on just what air conditions were desirable for the maintenance of health and comfort.

From that time until quite recently the installation of air-conditioning equipment has followed many courses, and the entire subject has been in a state of chaos. Now the old prejudices have been broken down, and air-conditioning is proceeding on a scientific basis.

While it is known that organic odors may produce nausea, loss of appetite and general malaise, the ill effects ascribed to impure, confined air are due, not so much to the chemical impurities in the air as to the physical properties, such as increased temperature, higher percentage of humidity and stagnation of the air surrounding the body.

LACK OF FRESHNESS IN AIR

Up to the present time, proponents of air-conditioning have failed to discover the cause of deadness or lack of freshness in the air. Two theories are advanced: one, the effect of ionization, and the other, the effect of ozone. Little is known at present regarding the ionization of air. Ions are produced by solar radiation, cosmic rays and radio-active changes in the soil. In unoccupied rooms the ionic content is about the same as outside air. In occupied rooms there is a marked decrease in the ionic content, which state prevails until the occupants leave the room, when the percentage immediately increases. Air-conditioning apparatus produces a definite decrease in the ionic content of the air. These facts may account for the lack of freshness in conditioned rooms.

Ozone is triatomic oxygen usually produced by a high-tension electric discharge. It is very unstable, and for that reason was thought to oxidize the impurities of the air. The usual concentration in nature is from .02 to .04 parts to one million. A concentration of .06 parts per million is necessary to be distinguishable to the sense of smell, and four parts per million is definitely irritating to mucous membranes. Inasmuch as a concentration of five hundred parts per million is necessary for germicidal use, the futility of ozone machines, as air purifiers, is readily seen.

AIR-CONDITIONING: ITS DEFINITION

Air-conditioning has been defined as the science of controlling the temperature, the humidity and the purity of the air, and its movement within closed spaces.

Air is considered a mechanical mixture, of which the main constituents are oxygen and nitrogen in the proportions of one to four. The other constituents are certain inert gases, such as helium, nitrone, argon and neon, and carbon dioxid. This last is always present in practically the same percentage, and is necessary for the growth of flora. Water vapor, though present in the air, is not a constituent of air.

Engineers have worked out what is known as a psychiometric chart to determine the percentage of moisture in the air. It takes into consideration the differences in temperature of the wet and dry bulb thermometers, and the results are expressed as percentage of humidity or relative humidity. Instruments have been devised that will measure the relative humidity within a reasonable degree of accuracy.

PRESENT-DAY MECHANICAL APPARATUS FOR AIR-CONDITIONING

Apparatus has been developed which will produce any desired atmospheric condition. Air can be cleaned, heated, cooled, humidified, dehumidified, and circulated. This apparatus may be a central unit, which will condition an entire building or

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a small unit for a separate office or hospital room. These machines have been perfected to a point where the relative humidity and temperature can be maintained at any desired point, and almost all of the pollens, etc., removed from the air, which is supplied.

With such machines at their command, the engineering profession is asking us, as medical men, what conditions we desire for our hospitals and patients. How shall we answer their questions, or is there a real need for air-conditioning in our hospitals, offices, and homes?

EFFECTS OF SUDDEN TEMPERATURE CHANGES

Mudd, Grand and Goldman, in 1921, in a series of experiments on humans, demonstrated that chilling of the body surface caused reflex vasoconstriction and ischemia in the mucous membranes of the nasal cavity and postnasal space, etc. They thought that this ischemia might cause a lowering of the local resistance, which would allow infection to occur. During the course of their experiments, ten of the subjects developed acute colds and sore throats, and an interesting change in the bacterial flora was noted.

Their experiments have been borne out by the sickness records in industry. Men who worked at trades where there were frequent sudden temperature changes are known to suffer more from upper respiratory diseases than in other trades. Most outstanding in this group are the steel workers, who labor for short periods in high temperatures and then cool off in rest periods.

HOW ATMOSPHERIC CHANGES AFFECT THE DEVELOPMENT OF PREMATURE INFANTS

Blackfan and Yaglou, in 1933, studied the effects of atmospheric conditions on the growth and development of premature infants. They compared the results of seven years' work in the conditioned nursery with the results of the three years previous to the installation of the system. They had one unit which maintained a low humidity, and another which maintained a high humidity. The general net mortality rates from acute upper respiratory infections showed a remarkable difference in the three nurseries. In the old, unconditioned nursery the percentage was 26.5 as compared with 9.7 per cent in the low relative humidity nursery, and zero per cent in the high relative humidity nursery. The mortality rate from all causes was 28.9 per cent in the unconditioned nursery; 14.9 per cent in the low relative humidity nursery, and 0.7 per cent in the nursery with high relative humidity.

To me, the most interesting part of their work has been the definite decrease in the percentage of respiratory infections in the infants kept in the nursery having the high relative humidity. The percentage relative humidity used was 65, with a temperature of 75 to 100 degrees Fahrenheit.

HAY FEVER AND POLLEN ASTHMA

The effect of conditioned air on hay fever and pollen asthma has been studied by many. It has been found that, while commercial filters as now manufactured are not 100 per cent perfect, those that remove all but traces of pollens will relieve symptoms of hay fever. Relief of symptoms was usually noted within ten to fifteen minutes after entering the conditioned rooms, and after two hours no evidence of the disease was found. Returning to the pollen-laden air immediately caused recurrence of the symptoms. Relief from pollen asthma was not gained as quickly as it was in those suffering from hay fever. The subjective symptoms of asthma diminished in a few hours, but the objective evidence disappeared less rapidly.

THE COMMON COLD

Kerr and Lagan, in their studies of the common cold, found that they were unable to infect a normal person so long as that person was in a properly conditioned room. The room used was kept at a relative humidity of 55 per cent, and a dry-bulb temperature of 70 degrees Fahrenheit. Twenty-eight normal subjects were inoculated with material from the nasal passages of patients suffering from severe acute colds, and none of them contracted colds or showed any symptoms referable to a cold. The series is a small one, but the results shown are certainly striking.

Rowe has found that the patients having hay fever or pollen asthma show definite improvement when placed in air-conditioned rooms. He uses a relative humidity of 40 to 45 per cent, and feels that the dryness is of assistance in the asthmatic particularly.

AIR-CONDITIONING INSTALLATIONS BY RAILROADS AND THEATERS

The railroads and theaters are installing air-conditioning from a comfort standpoint alone, and have found that their business has been increased considerably. They are using a humidity of around 50 per cent, and maintaining the temperature at about 10 to 15 degrees Fahrenheit below the outside temperature in the summer time, and around 70 degrees Fahrenheit in the winter time.

NEED OF AIR-CONDITIONING IN OFFICES, HOSPITALS, AND HOMES

I feel that there is a definite need for conditioned air in our offices, homes, and hospitals. Of course, it is not possible to have everyone in conditioned rooms every hour of the day. We can, at least, condition our offices and homes, or parts of them, and we certainly should have conditioned air in the hospitals.

COMFORT ZONES

The engineers have worked out what is known as a comfort zone for average individuals in winter and summer. In summer they found that a temperature of 71 degrees Fahrenheit and a relative humidity of 40 to 60 per cent was comfortable for most people. In winter the temperature was slightly lower at 66 degrees Fahrenheit, and a relative humidity from 40 to 50 per cent was most satisfactory. These data are applicable to normal individuals, who occupied the rooms for long periods of time as, for example, when in an office or home. If one is working out a com-

fort chart to be applied for short periods of time, the temperature and humidity must vary with the outside conditions, so that the shock of the sudden change will not be too great when passing from one place to another.

IN CONCLUSION

Each individual patient we see will present entirely different requirements for the conditions of the air to be supplied. The results shown by the various investigators, whom I have quoted, show this to be the case. For example, the nursery for the premature infant should be maintained at a relative humidity of from 60 to 65 per cent, and a temperature of from 80 to 100 degrees Fahrenheit, depending upon the age and weight of the patient. The asthmatic, on the other hand, responds much more quickly if the relative humidity is kept at 40 per cent. The patient who has a stuffy nose in an atmosphere of high relative humidity responds nicely to a humidity of from 48 to 50 per cent, and a temperature of about 68 degrees Fahrenheit.

In the extremely dry climates of the interior of our western states it will be necessary, at times, to add water to the air circulated to increase the humidity. Patients in these regions frequently complain of the extreme dryness and irritation of the mucous membranes of the nose and throat.

Our hospitals should be conditioned by the unit system so that individual rooms, or groups of rooms, can be maintained at any desired state. They can accommodate, in this way, any type of patient that may require care.

I have endeavored to outline, briefly, the subject of air-conditioning as it has been developed by the leading ventilating engineers. Its value in the management of diseases of the upper respiratory tract has been shown by many investigators. I hope this paper will serve as a stimulus for all of us to become more conscious of the atmospheric environment of our patients in the future.

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POLIOMYELITIS*

IN VITRO NEUTRALIZATION TESTS, USING NORMAL ADULT AND CONVALESCENT HUMAN SERUMS

I. INTRODUCTION

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DISCUSSION *by K. F. Meyer, Ph. D., San Francisco.*

DURING the outbreak of poliomyelitis in northern California in 1934, serum was collected both from patients who had recovered from the disease, and from so-called "normal" individuals. The pooled convalescent serums were given therapeutically to the active cases, four to twelve persons contributing toward each mixture. The pooled serums from adults having a negative history of poliomyelitis were used prophylactically for contact cases, eight to sixteen individuals contributing toward each of these.

The use of normal serum has been founded on the observations of numerous workers, who have estimated that between 70 and 80 per cent of the normal adult urban population possess neutralizing antibodies for the poliomyelitic virus. Based on these reports, and those of Davide [1] and of Flexner and Stewart,[2] for the prophylactic use of convalescent serum, Moro,[3] in Germany, suggested that "normal" adult serum, or the whole blood, should be administered prophylactically to young children in an epidemic. This type of passive immunization was used by Brebner [4] in the United States during 1932.

The normal serum collected in 1934 for the outbreak in northern California was divided into two classes, one obtained from the medical staff of the University of California Hospital and the other from outside volunteers. It was thought that members of the staff might have had greater opportunities for exposure to poliomyelitis and, therefore, possess more antiviral substances in their blood than the average adult. Serum was also collected from a group of professional donors who might be called on for direct transfusions if they proved suitable.

To determine the relative values of these several groups, *in vitro* neutralization tests were made on many of the normal and the convalescent pools, respectively, as well as on individual serums. The results will be presented, even though many workers have reported upon observations of a similar nature. All such data, however, may prove valuable as an aid in directing the course of public health policy during an epidemic or a time of sudden emergency.

II. METHODS

All neutralization tests were carried out with a standard dilution of 5 per cent cord suspension of a monkey passage virus kindly sent by Dr. M. Brodie of the New York University. Suspensions made from the same cord mixtures of one group of monkeys was used as the stock virus throughout all the different experiments over a period of several months. The 5 per cent suspension, made fresh about once a month, lightly centrifugated, maintained about the same degree of potency throughout this period, the M. L. D. being approximately a dilution of 1-800 or 0.00125 cubic centimeters. The standard amount used for the tests was a 1-25 dilution (0.04 cubic centimeters) or about 32 M. L. D. As many tests as possible were performed at one time for better purposes of comparison. Equal parts of the 5 per cent diluted virus, and the pools or single serums were mixed, placed at 37 degrees centigrade for two hours, and then kept overnight in the ice-box before injecting 1.5 cubic centimeters of each intracerebrally into monkeys, according to the method of Shaughnessy, Harmon and Gordon.[5] No preservative was put in the serums.

III. NORMAL ADULT SERUMS

Because of the high incidence of poliomyelitis among the older age groups (35.41 per cent) in

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